

CROP WATER REQUIREMENT FOR MAJOR CROPS GROWN IN VARIOUS AGRO-CLIMATIC ZONES OF ODISHA

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ABSTRACT

The present study aimed to find out the crop water requirement for the major crops grown in various Agro-climatic zones of Odisha. Results revealed that water requirement for Kharif season ranges from 333 mm to 480 mm for short duration paddy crop, from 470 mm to 629 mm for medium duration paddy crop and from 600 mm to 821 mm for long duration paddy crop, all over Odisha. Water requirement for Rabi season paddy varies from 402mm to 659mm, groundnut ranges from 270mm to 330mm, green gram ranges from 201mm to 317mm, black gram ranges from 242mm to 270mm, maize ranges from 290mm to 363mm, millet 269mm, sesamum ranges from 460mm to 494mm for all the zones. In summer season, short duration paddy is cultivated in some areas of Odisha. The water requirement varies from 540mm to 658mm. The crop reference evapotranspiration was estimated for all the major crops grown in different agro-climatic zones of Odisha. From the daily rainfall, the surplus irrigation requirement can be applied the crops of respective localities.

KEYWORDS: Crop Water Requirement, Odisha, Paddy, Green Gram, Groundnut

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INTRODUCTION

Water plays a vital role for every living being. Water is and will become scarce natural resource in the near future. A clear understanding of the water balance is essential for exploring water saving measures. Due to economic and environmental constraints on new water resources developments, and increasing municipal and industrial needs, agriculture's share of water use is likely to go down day by day. Water resources management is due to the increase of the population and water demand especially in the India, which is classified as arid and semi-arid regions. In India with such large population is facing unique challenges of water scarcity due to diverse geographical, climatic and geo-environmental conditions apart from unequal distribution of fresh water resources. On an average Odisha receives about 1500mm of rainfall, which is uneven, erratic and uncertain in nature. Therefore efficient and effective water management strategies are essential for meeting the increasing water demand of agricultural, domestic, industrial and environmental sectors. Agriculture is one of the important sectors, which utilises around 60% of fresh water resource. Agriculture is the backbone of India. Therefore, efficient water management is necessary in the field of agriculture. The investigation by McCabe and Wolock (1992), based on an irrigation model, concluded that the increase in mean annual water use is strongly associated with the increase in temperature. Panda *et al.* (1997) have reported attainment of higher yields in Orissa, by subjecting the crop to submergence of 5 ± 2 cm during tillering and 7cm during reproductive stages. In addition, Sahu (1967) reported water requirement of 1,440 mm in kharif season and 1,650 mm in Rabi season for growing rice in Bhubaneswar. ET_0 values can later be used for different purposes such as to derive

irrigation water requirement of crops, to obtain ET_0 estimate for locations with no meteorological data and to fill the gaps in available records of ET_0 . Keeping the above in view, the following objectives are selected for this study: Assessment of crop water requirement for major crops grown in various agro-climatic zones of Odisha

MATERIALS AND METHODS

Odisha lies at north latitude $17^{\circ} 78'$ and $22^{\circ} 73'$ and east longitude $81^{\circ} 37'$ and $87^{\circ} 53'$ with average elevation of 45 meters above MSL and a coast line of 480 km. It has a geographical area of 1,55,707 sq. km (4.87% of total area of India). The cultivable area, gross irrigated area and net irrigated area of the state are 61.80 lakh ha, 47.04 lakh ha and 33.66 lakh ha respectively. On an average the state receives a rainfall of 1500mm. Odisha is differentiated into ten different agro-climatic zones based on the basis of soil structure, humidity, elevation, topography, vegetation, rainfall and other agro climatic factors.. The analysis was carried out based on climatic data available at different agro- climatic stations. Thirty-three years of (1981-2013) daily climatic data of minimum and maximum air temperature, mean relative humidity, average wind speed, solar radiation, and rainfall were collected from the website <http://global.weather.tamu.edu/home/view/13292>.

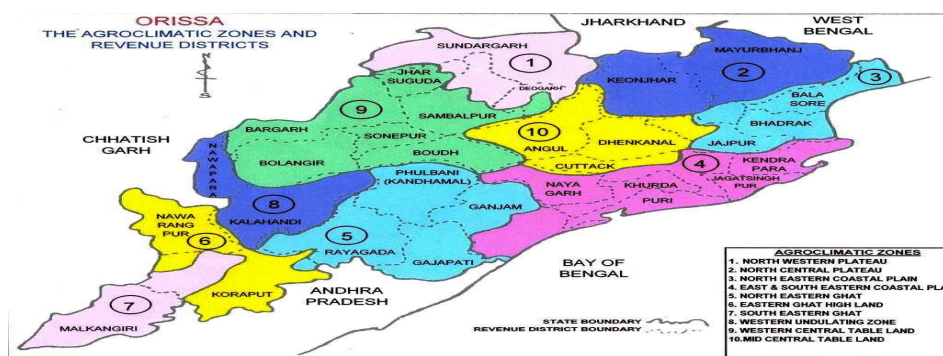


Figure 1

The amount of water required to compensate the evapotranspiration loss from the cropped field is defined as crop water requirement. Water requirement of the crops depend mainly on the nature and stage of growth of the crop and environmental conditions. Different crops have different water-use requirements under the same weather conditions. The same crop may have different water requirements at different places of the same country; depending upon the climate, type of soil, method of cultivation and useful rainfall.

ESTIMATION OF CROP WATER REQUIREMENT OF MAJOR CROPS

Depending upon the cropping season 3 major growing seasons are noticed like Kharif, Rabi and Summer. Eight Rabi crops, one summer paddy and three types of Kharif paddy are selected for the study as the major crops of ten different agro-climatic zones of Odisha as stated in Table 1. Reference crop evapotranspiration for thirty-three years for all crops were calculated by using FAO-56 PM method. On the basis of average ET_0 for any day during the crop period of any crops daily crop water requirement was estimated by multiplying crop coefficient (K_c), presented in Table 2, value to the estimated ET_0 from FAO-56 PM method.

CROP SELECTION

In Odisha, paddy is the major crop during the Kharif season, summer season and also in Rabi season. In different

parts of the state all varieties of paddy, i.e., long, short and medium duration are almost equally cultivated during the kharif season. During summer and rabi season, short duration and medium duration paddy are cultivated respectively. And in Rabi season, different pulses, oilseeds, are grown as major crops as listed in Table 1.

CROP COEFFICIENT APPROACH

In the crop coefficient approach the crop evapotranspiration, ET_c , is calculated by multiplying the reference crop evapotranspiration, ET_0 , by a crop coefficient, K_c

$$ET_c = K_c * ET_0$$

Where

ET_c = crop evapotranspiration [$mm\ d^{-1}$],

K_c = crop coefficient,

ET_0 = reference crop evapotranspiration [$mm\ d^{-1}$]

Table 1: Major Crops Information of the Study Area

Sl. No.	Name of zones	Research Station	Soil type	Major Crops		
				Summer	Kharif Season	Rabi season
1.	North Western Plateau	Kerai (Sundargarh)	Red & yellow		Paddy	Paddy, Groundnut, Green gram, Maize
2.	North Central Plateau	Keonjhar	Red loamy		Paddy	Paddy, Groundnut, Maize
3.	North Eastern Coastal Plain	Ranital (Bhadrak)	Alluvial	Paddy	Paddy	Paddy, Green gram, Black gram, Groundnut
4.	East & South Eastern Coastal Plain	Bhubaneswar	Coastal alluvial saline (near the coast line)	Paddy	Paddy	Paddy, Groundnut, Green gram
5.	North Eastern Ghat	G. Udaygiri (Kandhamal)	Laterite and brown forest	Paddy	Paddy	Paddy, Groundnut, Green gram, Black gram
6.	Eastern Ghat Highland	Similiguda (Koraphut)	Red mixed red & yellow		Paddy	Paddy, Maize, Wheat
7.	South Eastern Ghat	Kalimela (Malkanigiri)	Red, mixed red & black		Paddy	Paddy, Millet, Sesamum
8.	Western Undulating Zone	Bhawanipatna	Black, mixed red and black		Paddy	Paddy, Sesamum, Maize
9.	Western Central Table Land	Chipilima	Red, heavy textured colour		Paddy	Paddy, wheat, Groundnut, Green gram
10.	Mid Central Table Land	Mahisapat (Dhenkanal)	Red loamy, laterite mixed red & black		Paddy	Paddy, Green gram, Black gram

Table 2: Crop Coefficient for Different Crops at Different Stages

CROPS	Total Duration	Stages (in duration)				K _c value for different stages			
		Initial Stage(I)	Crop Dev. (II)	Mid Season (III)	Late season(IV)	Initial Stage(I)	Crop Dev. (II)	Mid Season (III)	Late season(IV)
Paddy-I	90	15	25	30	20	1.00	1.05	1.20	0.90
Paddy-II	120	15	50	25	30	1.00	1.05	1.20	0.90
Paddy-III	150	15	30	60	45	1.00	1.05	1.20	0.90
Wheat	120	15	25	50	30	0.35	0.75	1.15	0.45
Green gram	60	10	20	20	10	0.35	0.70	1.10	0.90
Black gram	70	10	25	25	10	0.35	0.70	1.10	0.90
Groundnut	137	25	30	40	25	0.45	0.75	1.05	0.70
Maize	125	20	35	40	30	0.3	0.6	1.2	0.35
Sesamum	90	15	25	35	15	0.35	0.7	1.15	0.25
Millet	100	15	25	40	20	0.35	0.6	1.0	0.3

Crop duration and crop stages are taken from Agril. Handbook and K_c values of the selected crops are taken from FAO 24, irrigation and drainage paper.

RESULTS AND DISCUSSIONS

Estimation Water Requirements (CWR) for Major Crops

Water requirement for major crops grown in ten different agro-climatic zones of Odisha were estimated by taking reference evapotranspiration of respective localities and crop coefficient of the respective crops. The crop water requirements for major crops are discussed as follows.

Crop Water Requirements (CWR) for Major Crops for the North Western Plateau Zone

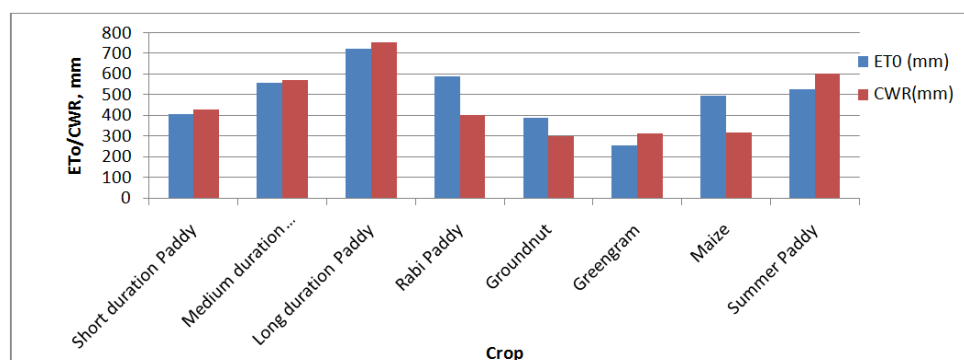


Figure 2: ET₀ Vs CWR for North Western Plateau Zone

Crop Water Requirements (CWR) for Major Crops for North Central Plateau Zone

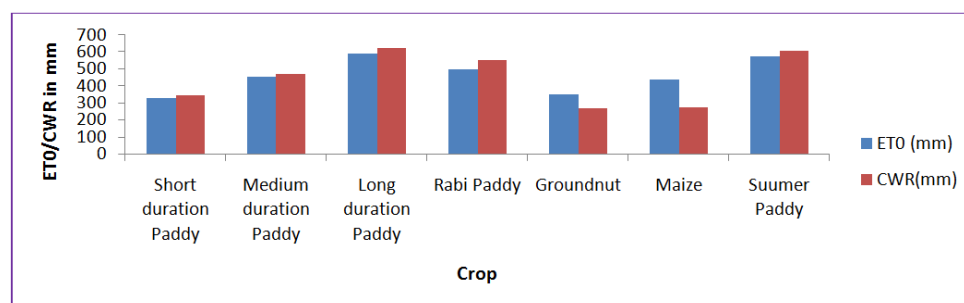


Figure 3: ET₀ Vs CWR for North Central Plateau Zone

3.1.3 Crop Water Requirements (CWR) for major crops for North Eastern Coastal Plain Zone

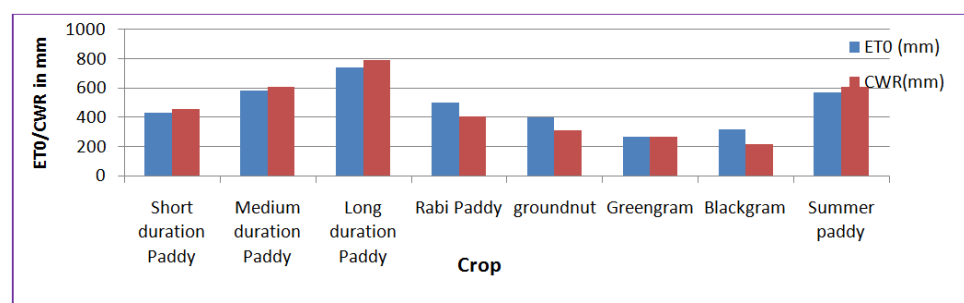


Figure 4: ET₀ Vs CWR for North Eastern Coastal Plain Zone

Crop Water Requirements (CWR) for Major Crops for East and South Eastern Coastal Plain Zone

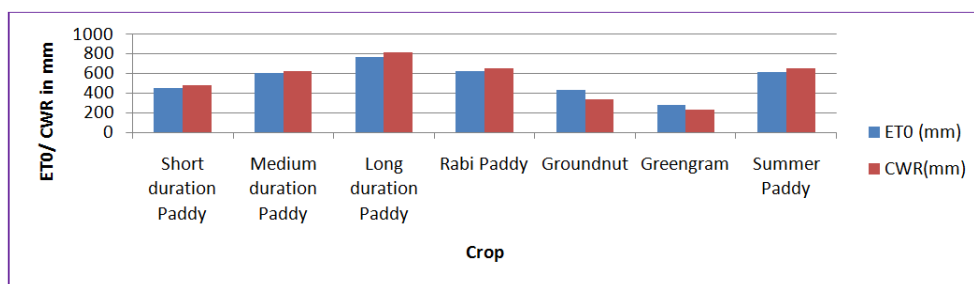


Figure 5: ET₀ Vs CWR for East and South Eastern Coastal Plain Zone

3.1.5 Crop Water Requirements (CWR) for major crops for North Eastern Ghat Zone

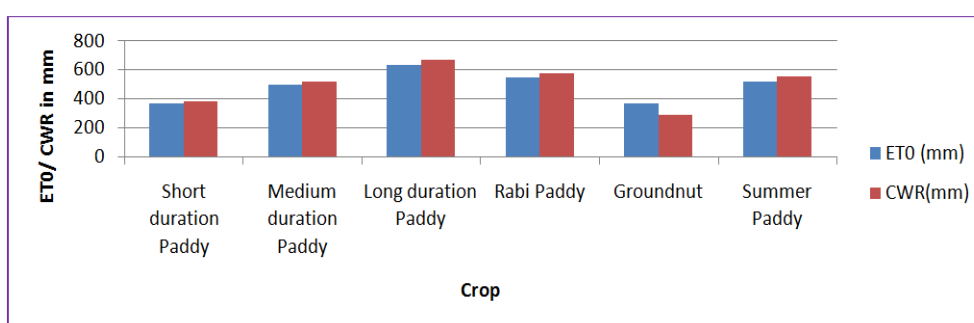


Figure 6: ET₀ Vs CWR for North Eastern Ghat Zone

Crop Water Requirements (CWR) for Major Crops for Eastern Ghat Highland Zone

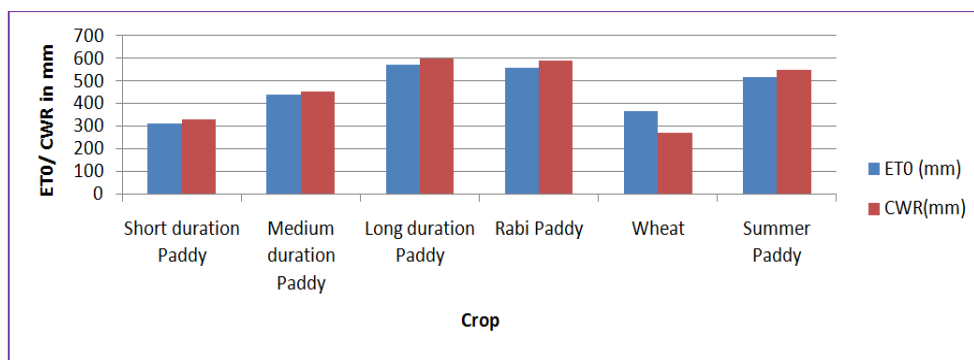


Figure 7: ET₀ Vs CWR for Eastern Ghat Highland Zone

Crop Water Requirements (CWR) for major crops for South Eastern Ghat Zone

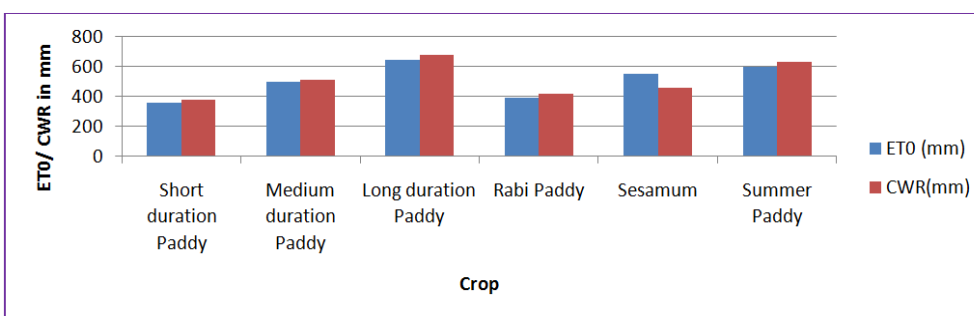


Figure 8: ET₀ Vs CWR for South Eastern Ghat Zone

Crop Water Requirements (CWR) for Major Crops for Western Undulating Zone

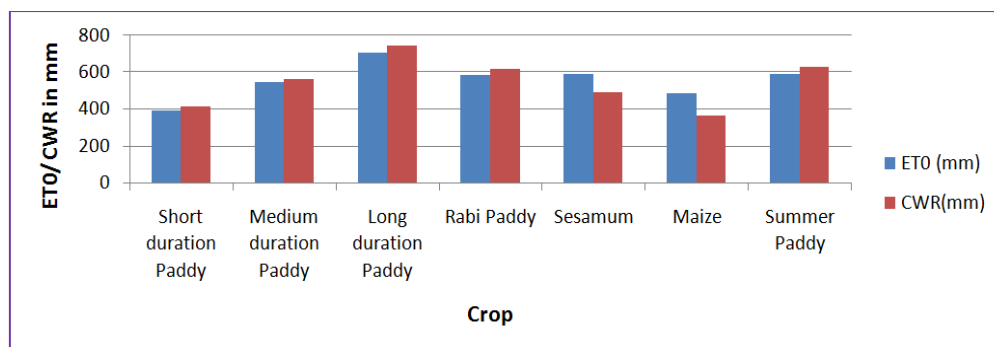


Figure 9: ET₀ Vs CWR for Western Undulating Zone

Crop Water Requirements (CWR) for Major Crops for Western Central Table Land Zone

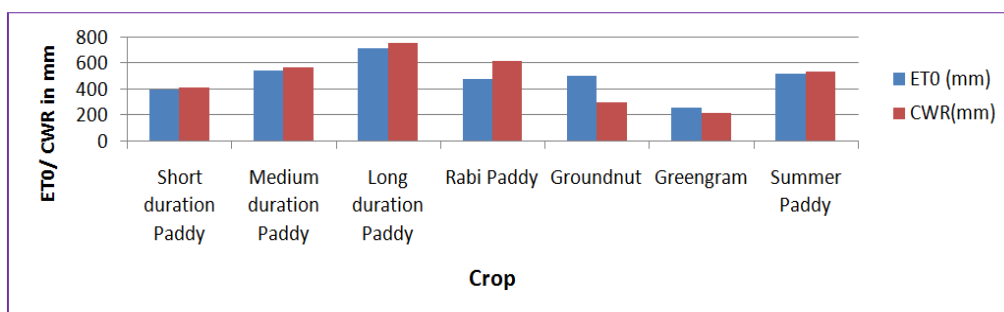


Figure 10: ET₀ Vs CWR for Western Central Table Land Zone

Crop Water Requirements (CWR) for Major Crops for Mid Central Table Land Zone

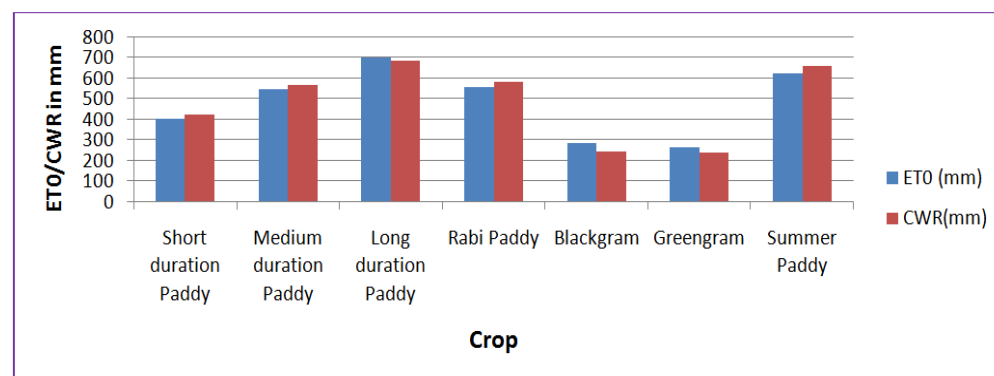


Figure 11: ET₀ Vs CWR for Mid Central Table Land Zone

CONCLUSIONS

The crop reference evapotranspiration was estimated for all the major crops grown in different agro-climatic zones of Odisha. From the daily rainfall, the surplus irrigation requirement can be applied the crops of respective localities. The following specific conclusions could be drawn from the present study. Water requirement for Kharif season ranges from 333 mm to 480 mm for short duration paddy crop, from 470 mm to 629 mm for medium duration paddy crop and from 600 mm to 821 mm for long duration paddy crop, all over Odisha. Water requirement for rabi season ranges from 402mm to 659mm for paddy crop, from 270mm to 330mm for groundnut, from 201mm to 317mm for green gram, from

242mm to 270mm, from 290mm to 363mm for maize, 269mm for millet, ranges from 460mm to 494mm for sesame, throughout all the zones. In summer season, short duration paddy is cultivated in some areas of Odisha for which the water requirement varies from 540mm to 658mm.

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